Beverage Intake of U.S. Children by Weight Status

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Between 1989 and 2008, there was a significant increase in sugar-sweetened beverage consumption in children.[1] According to the Evidence Analysis Library of the Academy of Nutrition and Dietetics, there is evidence of a link between sugar-sweetened beverage (SSB) intake and childhood overweight and obesity (OW/OB).[2] In addition, a review by Malik et al. found a positive association between higher SSB consumption and weight gain in both children and adults.[3] There is certainly a body of evidence linking SSB consumption to childhood OW/OB, although conversely, both cross-sectional and prospective studies examining this relationship have found no association.[4,5]

While there have been several studies examining SSB consumption, few have examined SSB intake in the context of other beverage intakes, and even fewer have examined this beverage intake by weight status.[4–6] Two of these studies examined only preschool aged children[5,6], and none have included data past the year 2005.

Childhood obesity remains a major public health concern and beverage intake has been identified as a potential intervention point. However, the first step towards intervention is assessing the current state of beverage related behaviors to elucidate where intervention may be most effective. The purpose of this study was to examine beverage intake patterns, by weight status, for children in the U.S. during the years of 1999-2010. Our overall goal was to update the body of literature describing beverage intake by weight category.

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Methods

Study population

Data from the 1999-2010 National Health and Nutrition Examination Survey (NHANES) were analyzed to assess beverage intake. NHANES is a nationally-representative nutrition monitoring system to assess the health status of the US non-institutionalized population.[7] Oversampling of targeted populations was employed to obtain adequate samples for meaningful subgroup analyses. Participants were include in these analyses if they were 2-18 years of age and provided a valid and reliable 24-hr dietary recall data (n=21,067). The procedures for data collection are described in detail elsewhere.[7] Briefly, a trained interviewer collected dietary data during the visit using the validated multiple-pass technique.[8,9] All foods reported as consumed were entered into the computer-assisted dietary interview system to estimate the portion size, time, meal name and preparation modifications and nutrient intakes per food reported. A proxy interviewee, ideally the person responsible for preparing the child's meals, provided all responses for children under six years old. Interviews for children aged 6-11 years were conducted with proxy assistance. Measurement guides were used to assist in estimating portion size throughout the interview. Children were categorized as normal weight (NW), overweight (OW), and obese (OB) using standard CDC weight-for-height percentiles calculated from their measured height and weight. Underweight children were excluded from analysis.

Dietary data development

Nutrients from each reported food and beverage were computed using the US Department of Agriculture's (USDA) Food and Nutrient Database for Dietary Studies (FNDDS) and dietary guidance systems food group intakes. Discretionary fat and added sugars were estimated using the MyPyramid Equivalents (MPED) database. Because the MPED version 2 was developed for

dietary data up through 2003-2004, an addendum from the USDA Center for Nutrition Policy and Promotion was used to produce MPED data through 2005-2006. The remaining foods that were unique to survey years 2007-2008 and 2009-2010, and therefore not included in the previous versions of MPED, were manually computed to generate a complete dietary data set for nutrients and MPED equivalents through 2010.

We examined grams of intake per beverage, calories of intake per beverage, calories of added sugar per beverage, and percent consumers of each beverage. A consumer was defined as a child who had the beverage at least once on the day for which their 24-hour recall was collected.

Coding the beverages

All beverages were manually coded into 16 mutually exclusive categories. These narrow categories were then collapsed into 12 broad mutually exclusive categories (see Fig. 1) and 8 of these categories were combined to create the non-mutually exclusive SSB category.

Initial beverage categorization	Broad beverage categorization
100% juice	100% juice
Tea, regular	Coffee and tea
Coffee, regular	
Milk or milk substitute, no sugar added	Milk or milk substitute, no sugar added
Energy drinks, diet	Low-calorie beverages
Low-calorie fruit drink	
Soda, diet	
Sports drinks, diet	
Energy drinks, regular	Sugar sweetened beverages
Fruit juice/drink	
Milk drink	
Milk or milk substitute, sugar added	
Smoothie	
Soda, regular	
Sports drinks, regular	
100% juice sugar added	

Figure 1: Beverage categorization for analysis

Statistical analyses

Data from the six 2-year cycles were combined for analysis into a single, nationally-representative sample. Analysis of variance was used to evaluate differences in mean gram and calorie intakes across weight categories. Chi squared analysis was used to evaluate differences in number of consumers across weight categories. To account for the complex sampling design used in NHANES data collection, the data analyses were weighted in SPSS Complex Samples (version 19, IBM, Chicago, IL). Significance was determined *a priori* at $p<0.05$.

Results and Discussion

Grams of beverage

Grams of intake by weight category can be seen in Fig. 2. For all children together, soda, milk, and fruit drinks were the top three individual beverages based on grams of intake (267g/day, 236g/day, and 163g/day respectively). However, the broad category of SSBs was the overall highest in terms of grams of consumption, with a mean of 495g/day for all children together. Soda accounted for more than half of the grams of SSB. Significant differences in intake were seen across weight categories for SSBs, soda, and low-calorie beverages. Obese children drank significantly more grams of SSB than normal weight children, but not overweight children. Both overweight and obese children drank significantly more grams of soda than normal weight children. Obese children drank more than twice the amount of low-calorie beverages as normal weight children and significantly more grams than overweight children as well. There were no significant differences seen in any other beverage category.

In a group of 2-5 year old children, O'Connor et al. found no association between weight status and the amount of total beverages, milk, 100% fruit juice, fruit drink, or soda consumed.[6] Since our data included children up to 18 years old, it is possible that we saw differences in soda

intake that were not yet evident in young children. Future analyses of the data will include an examination of intake by age category which will further elucidate any age disparities in intake. Alternatively, it is possible that changes in soda intake have occurred since 1999-2002 (the years for which O'Connor et al. collected data) and significant difference in intake can now be seen. However, similar to O'Conner et al., we found no differences in grams of milk, 100% fruit juice, or fruit drink between weight categories. SSB consumption has been shown to be positively correlated with BMI in adults.[10,11]

Similar to our findings, observational studies in adults have shown that those who consume more non-caloric sweeteners (like those found in low-calorie beverages) tend to have a higher body weight or BMI.[10,11] Though there has been some debate over the role of non-caloric sweeteners in obesity, we cannot infer causality from these findings. However, our data show that obese children drank a significantly higher volume of low-calorie beverages. One possible explanation is that obese children have a higher volume of intake in general, however the lack of significant differences in many of the other beverage categories hurts this hypothesis. Mullie et al. found that those who were trying to lose weight were more likely to consume low-calorie beverages but not any less likely to drink SSBs. We did not assess desire for weight loss in our current study, however this presents another plausible hypothesis for the higher intake of low-calorie beverages seen in obese children. Intent to lose weight is assessed via questionnaire as part of the data collected by NHANES and its relationship with beverage intake in children may be an area for future research.

Calories from beverages

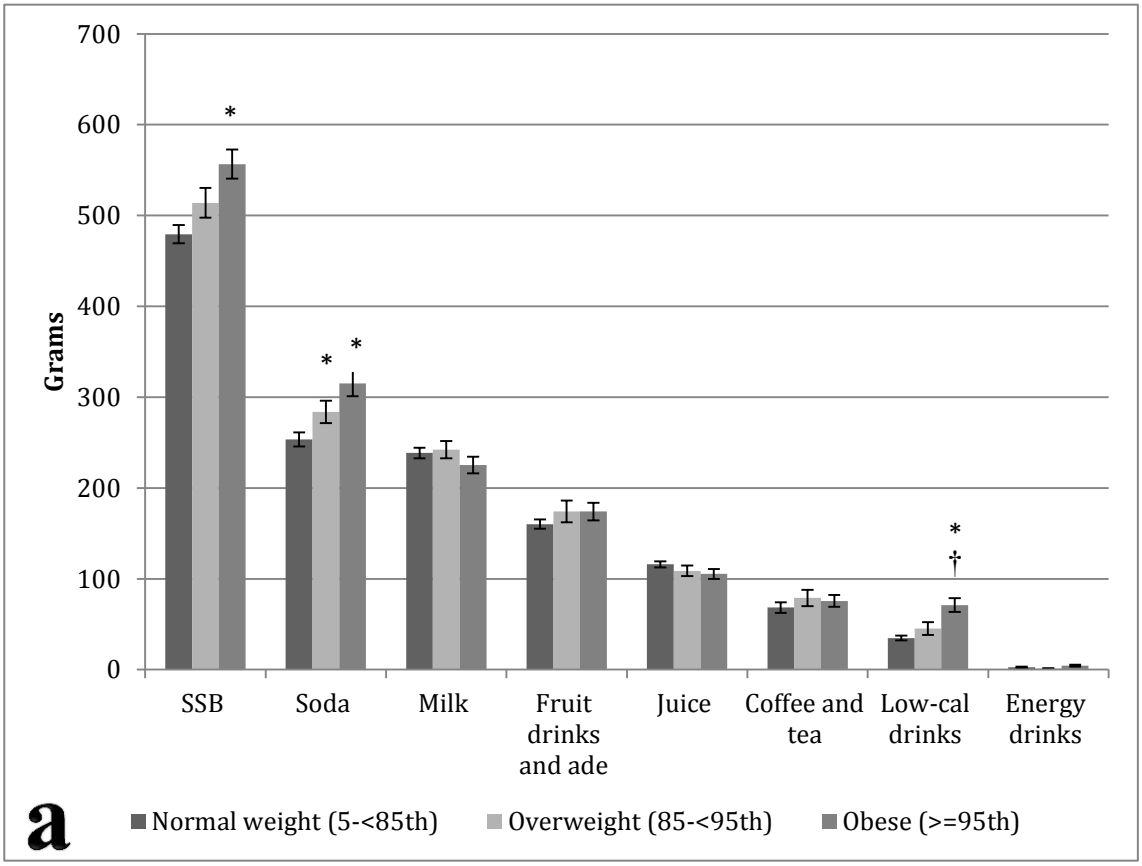
Calories from beverage by weight category can be seen in Fig. 2. The patterns seen in caloric intake form beverage mirrored those seen for grams of beverage. The top three sources of

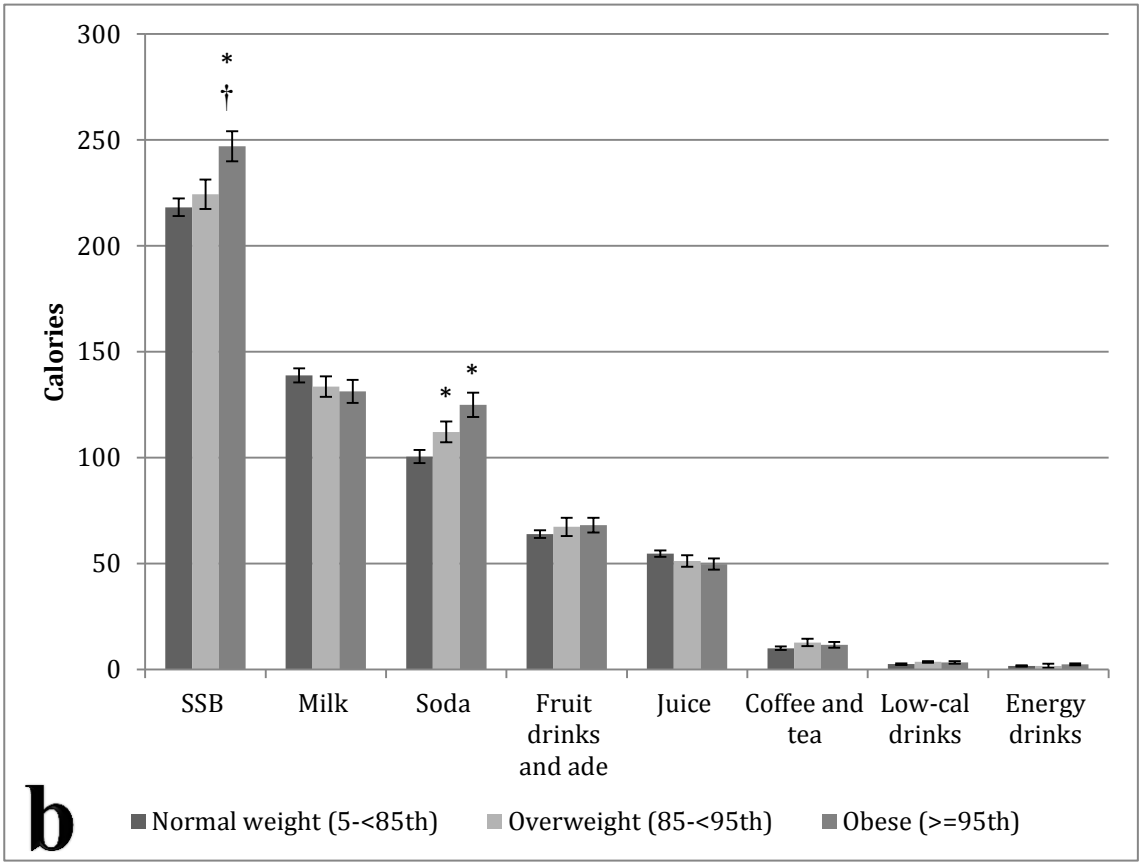
calories from individual beverages were milk, soda, and fruit drinks (137kcal/day, 106kcal/day, and 65kcal/day respectively). SSBs were the highest overall source of calories with a mean of 223kcal/day for children overall. Obese children drank more calories from SSBs than both normal weight and overweight children. Both OW and OB children drank more calories from soda than NW children. Mean caloric intake from all beverages was 380 kcal/day, 392 kcal/day, and 401 kcal/day for normal weight, overweight, and obese children respectively. These point estimates increase if we examine mean intake for only those who actually consumed a particular beverage, instead of averaging across all children. For example, the mean caloric intake for soda across all children was 106 kcal/day. However, mean intake for the consumers only was 224 kcal/day. A similar effect is seen for SSBs; overall mean intake was 222 kcals and mean intake for consumers only was 295 kcals.

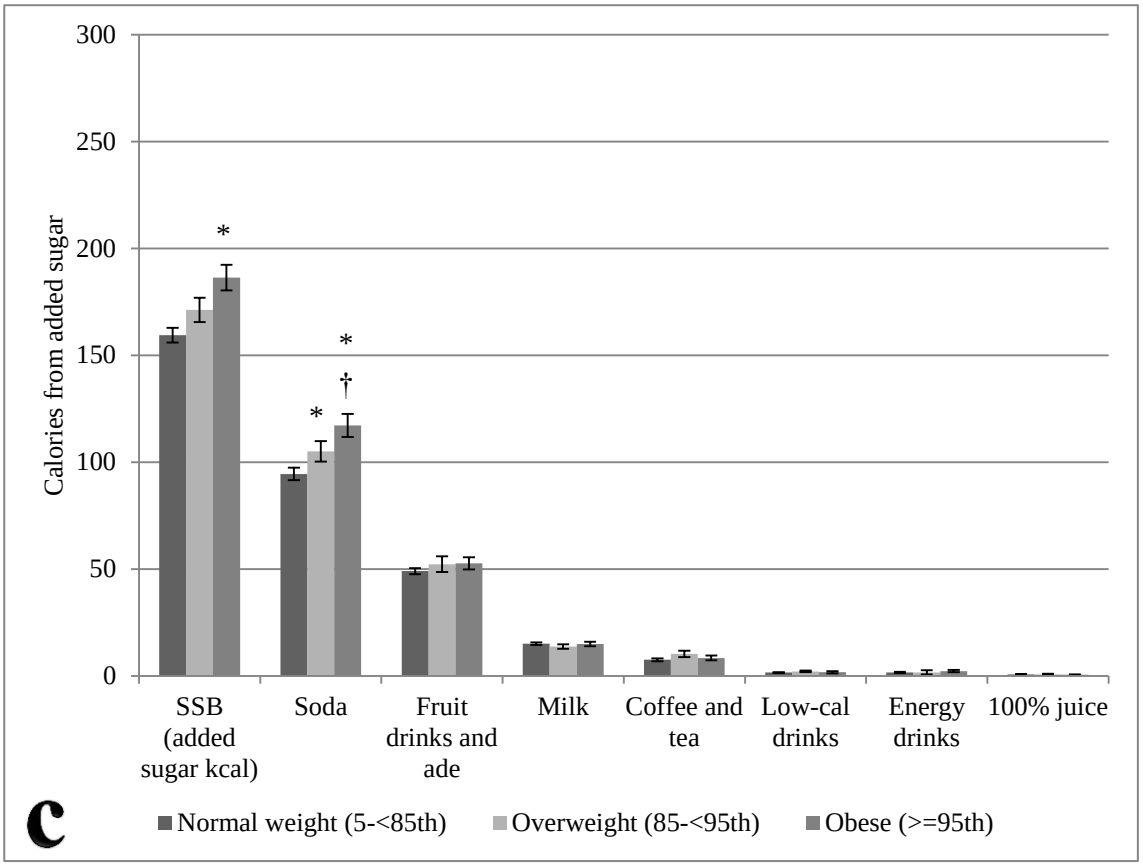
Calories from added sugar

Significant differences in calories from added sugar between weight categories followed the same pattern as overall calories. Differences were seen in SSBs overall, as well as soda. The overall mean for all children was 165 kcal from added sugar/day from SSBs and 99 kcal from added sugar/day from soda. Soda was the largest individual beverage contributor of calories from added sugar.

Figure 2a, b, c: Mean (SE) daily grams, calories, and calories from added sugar from select beverages by weight category (*significantly different from NW, †significantly different from OW; $p>0.05$)







Percent consumers

There were significant differences in percent consumers in nearly all beverage categories (see Fig. 3), though there did not seem to be any consistent patters for direction of the relationships across beverage categories. Percent consumers of SSBs, soda, and low-calorie beverages increased as weight category increased. Percent consumers of milk and 100% juice decreased as weight category increased. The percent of children who consumed coffee/tea and energy drinks did not vary across weight categories. The odds of an obese child drinking at least one SSB was 1.29 times the odds of a normal weight child, however 75% of normal weight children drank at least one SSB.

In a sample of 2,314 children ages 6-18, Dodd et al. found that, similar to our findings, a higher percentage of obese children consumed low-calorie beverages as compared to normal

weight children.[4] However, the only other differences found in percent consumers by weight category by Dodd et al. was in 100% fruit juice, and this difference between weight categories was only seen for middle-school children. Furthermore, unlike our results, Dodd et al. found that overweight children had the highest percent of consumers, whereas in our data normal weight children had the highest percent of consumers. It is possible that, if we were to examine our results for only the years 2005-2006 (the years of data collection for Dodd et al.), we would see patterns more similar to their findings.

Since the 1999-2000 survey cycle, the number of consumers of SSBs and soda have decreased. In the 1999-2000 survey cycle, 80% of children consumed SSB at least once and 56% consumed soda at least once. In 2009-2010, 69% and 35% of children consumed at least one SSB and soda, respectively. This may be evidence that public health messaging and policies encouraging less SSB intake has had an impact. Despite the current controversies and public debate surrounding energy drinks, the percent of children who reported consumption in their 24-hour recall was relatively low.

Beverage Category	Normal Weight	Overweight	Obese	*P*
Sugar-Sweetened Beverages	75% (0.7%)	75% (1.2%)	79% (1.1%)	<0.05
Milk	58% (0.8%)	54% (1.2%)	52% (1.6%)	<0.05
Soda	46% (0.9%)	50% (1.5%)	51% (1.4%)	<0.05
Fruit and ades	35% (0.8%)	32% (1.2%)	35% (1.3%)	<0.05
100% Juice	35% (0.8%)	32% (1.3%)	30% (1.2%)	<0.05
Coffee and tea	15% (0.7%)	16% (1.2%)	16% (1%)	NS
Low-calorie drinks	10% (0.6%)	11% (1%)	14% (1%)	<0.05
Energy drinks	1% (0.2%)	1% (0.3%)	2% (0.4%)	NS

Figure 3: Percent reporting beverage consumption in 24-hr recall

Limitations and future directions

One limitation of this study was that water not included in the analysis. Inclusion of water in future analyses may provide further context for beverage consumption patterns. We also did not examine the data by age, race, and socioeconomic status, which may provide additional detail on beverage intake in specific population groups.

Additionally, any method for diet assessment has its limitations. The method used by NHANES is a validated, and widely accepted for of diet assessment, however since the recall is performed 24 hours after the actual intake, errors may be introduced. The alternative methods of a food-frequency questionnaire or diet record introduce errors of their own and diet records are not feasible in the amount of time allotted for NHANES data collection.

Conclusions

This study examined a large sample of children and includes the most recent nationally representative beverage intake data. Our results show that soda and low-calorie beverages are the beverage categories with the largest disparities based on weight status. Not only did obese children drink more grams and calories from soda, but they were also more likely to consume soda on the day for which the 24-hour recall was conducted. More research is needed to determine the direction of causality in these relationships. However, our results also show that children in all weight categories are consuming a large number of calories from soda. As public health initiatives to decrease SSB intake become more and more prevalent, soda intake remains an important messaging point and may potentially play a role in the prevention of obesity development for normal weight children. It is also important to note the beverage categories which did not show any differences across weight categories. Most of the beverages examined did not show differences and therefore, interventions may be most successful if focused on the

specific beverage categories where disparity between weight categories was greatest. Future studies which examine beverage intake by sex, race, and SES will elucidate intervention strategies for specific populations.

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